

## DIFFERENTIATING CONTEXTS ACROSS EUROPEAN AVALANCHE COMMISSIONS TO SUPPORT FUTURE DEVELOPMENT: AN INVITATION TO UNIFY EFFORTS

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**ABSTRACT:** The risk from avalanches to infrastructure and the general public is managed in a wide range of contexts that differ in operational scale, number of paths, size and frequency of avalanches, and complexity of hazard situations. Similarly, the people managing these risks also vary considerably, ranging from part-time individuals for whom avalanche risk management is only a minor part of their work to large teams of career-long avalanche safety professionals engaged daily with in-depth risk management. While research in the physical sciences has made substantial contributions to characterizing avalanche hazard situations, a structured characterization of the avalanche safety community has yet to be formally established using social science research. The currently limited understanding of the industry landscape and risk management contexts poses a considerable hurdle for designing effective operational tools and supporting industry development.

To address this knowledge gap, we will conduct a survey of the avalanche commissions in Switzerland, Tyrol, Austria, and Trentino and South Tyrol, Italy during the 2024-2025 season. To approach the study systematically, we will apply audience segmentation methods that have shown promise in studies of winter backcountry recreationists. We will apply these methods to a set of variables derived from a conceptual framework of avalanche risk reduction that was created to better inform product design and evaluation by characterizing avalanche risk management situations in a comprehensive and systematic way. The expected outcomes of this work are 1) a detailed overview of the avalanche commission landscape in central Europe, and 2) detailed descriptions of typical contexts for avalanche commissioners to better highlight distinct needs, facilitate knowledge transfer, inform succession planning, and direct the design of educational materials and information systems.

**KEYWORDS:** Avalanche commissions, operational avalanche risk management, program development, product design.

### 1. INDUSTRY NEED

The avalanche safety community currently faces several challenges that can fundamentally change how avalanche risk is assessed and managed in the future. First, the industry is currently undergoing a generational shift with many long-term avalanche practitioners with extensive expertise retiring (e.g., Caviezel et al., 2024). The workplace expectations of future practitioners are anticipated to differ from those of their predecessors and may include preferences for increased remote-work flexibility or shorter tenures with employers. Second, recent advances in monitoring systems, snowpack simulations, and information technology have resulted in an unprecedented wealth of information for assessing avalanche

hazard conditions. While industry workers increasingly depend on these new data sources for their decisions, the magnitude of the available information can also be overwhelming and hinder the assessment process. And third, the effects of climate change are expected to further heighten the uncertainty practitioners face, rendering historical data and past experiences less reliable.

Meanwhile, societal expectations are pushing for greater accuracy and standardization in services. Practitioners are subject to pressure for minimal delays to industrial projects, maximum efficiency with road closures, and optimized access to complex terrain in ski areas. Bringing avalanche industry services to this level of adaptation and performance requires designing products and tools that can rise to meet these challenges. Industry agencies have recognized this need (e.g., EAWS, 2023) and have initiated projects to develop more targeted training programs and standardized information products. Examples are "Project CAIROS" (Winkler et al., 2024) or the "SILS-Stärkung

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Lawinensicherheit” initiative (Schweizerische Interessengemeinschaft Lawinensicherheit, 2023).

Following the “Establish context” step in the risk management process described in the *ISO 31000 Risk management—Principles and guidelines* (ISO, 2018), one of the foundational ingredients for making meaningful progress in this area is a systematic examination of the various contexts and roles in which avalanche practitioners operate. In Europe, a well-established workplace for avalanche practitioners is with local avalanche commissions. An avalanche commission is an advisory body responsible for assessing avalanche hazard to inform risk reduction measures, such as road closures, ski area management, or evacuation warnings (Amt der Tiroler Landesregierung, 2016, 2022; Rhyner & Schweizer, 2015). Avalanche commissioners often work closely with local governments, transportation authorities, and ski resorts to reduce avalanche risk to residents, tourists, and infrastructure in avalanche-prone areas. Despite the consistency in the position title, avalanche commissioners actually encompass a wide range of practitioner roles (e.g., ski patrol leaders, mountain guides, snow scientists, and other professionals with specialized knowledge in avalanche dynamics and risk management) with different backgrounds, experiences, work practices, and responsibilities.

While research in risk communication highlights the importance of “getting to know thy audience,” for the design of effective information products and training programs (e.g., Fischhoff, 1995; Lundgren & McMakin, 2018), to our knowledge, there has yet to be a systematic study of meaningful differences across workplace environments and practitioner profiles. The goal of this project is to contribute a detailed characterization of typical avalanche commissions to inform more targeted development of effective support services.

## 2. PROPOSED APPROACH

To address this research question, we are conducting a detailed online survey to comprehensively characterize avalanche commissions in the Austrian state of Tyrol, the Italian provinces of Trentino and South Tyrol, and Switzerland during the 2024-25 winter season. This region of Europe is densely populated, multinational, multilingual, and follows the main chain of the Alps. In addition to hosting world-renowned winter recreation opportunities, the region also maintains roads and

railways that are essential to transit and trade between northern and southern Europe.

There are considerable differences in how avalanche commissions work across the study area. For example, the commissions are organized into jurisdictions based on different criteria. In Switzerland and Tyrol, commissions correspond with a particular element(s)-at-risk, such as a specific ski resort, highway corridor, or residential settlement. Alternatively, in Italy’s South Tyrol and Trentino provinces, avalanche commissions mainly correspond with a designated municipality or municipalities. In addition, avalanche commissions range in size from a minimum of three members to a maximum of ten. Table 1 provides approximate numbers of avalanche commissions and membership estimates.

Table 1: Avalanche commissions across sample regions of the central/eastern Alps

<i>Geopolitical region</i>	<i>Approx. # of commissions</i>	<i>Approx. # of total members</i>
Switzerland (CH)	70	200
Tyrol (AT)	250	1200-1400
South Tyrol (IT)	50	300-400
Trentino (IT)	30	230

### 2.1 Conceptual framework

To meaningfully characterize avalanche commissions, we need to collect and compare data that goes beyond traditional baseline information, such as age distributions, years of experience, or level of formal training.

We plan to use an emerging conceptual framework by St. Clair and Haegeli (2023) to guide our characterization of avalanche commissions and their context (Fig. 1). The framework applies a social-ecological systems perspective (McGinnis & Ostrom, 2014) to organize and understand the effectiveness of avalanche risk reduction efforts. It does this by prompting a comprehensive and detailed look at the systems’ principal components, interactions, and defining characteristics (Fig. 1).

The three principal components of the conceptual framework are comprised of: 1) the element(s)-at-risk, 2) the avalanche hazard situation(s)\*\*, and 3) the avalanche risk reduction service(s), which can include existing information products like the public avalanche forecast, decision support tools such as mapping products, or entire avalanche safety programs (Fig. 1). For the present study, we focus on avalanche commissions, an avalanche risk reduction service, as the starting point from which to define the elements of the system.

\*\* For our terminology, we apply the practical definitions by Statham (2008) in which avalanche hazard and avalanche danger are synonymous and represent the source of potential harm. This is distinctly different from risk, which includes the characteristics of the element(s)-at-risk.

In addition to the components themselves, the interactions between them are key to understanding the system. The three interactions between the principal components are: 1) the extent to which the element-at-risk interacts with the avalanche hazard situation (i.e., exposure), 2) the extent to which services represent/understand the nature of the avalanche hazard and how the hazard can be managed, and 3) how the risk reduction service and the element-at-risk interact with each other (Fig. 1).

For each of the components and interactions, the conceptual framework provides overarching guiding questions that help to produce detailed insight into the nature of different avalanche commissions. For example, Figure 1 includes example prompts that correspond with each of the principal components and their interactions:

- What are the characteristics of the element(s)-at-risk?
- What are the relevant avalanche hazard situations?
- How is the element-at-risk exposed to the avalanche hazard?
- What is the structure, function, mandate, and authority of the avalanche commission?
- Can the hazard be accurately represented and actively managed?
- How is the risk to the element-at-risk managed and/or communicated?

While service providers have based strategic decisions and program development on some of the

components or characteristics present in the system, having a structured approach that prompts people to think about all of the different components and their interactions will ensure a more comprehensive approach to product design and program evaluation.

When applying the conceptual framework to a specific context, the different components and interactions are characterized in greater detail. This is useful because there can be distinctly different implications for product development when designing for an audience of avalanche experts compared with an audience of novice recreationists. Likewise, there are distinctly different implications for evaluating product effectiveness in situations involving a particular hazard situation, such as an atmospheric river versus a deep persistent slab avalanche cycle. Fittingly, the framework can be adapted and scaled to any starting point within the system. It is equally suited for exploring the effectiveness of a global product like the avalanche danger scale for recreational snowshoers as it is for an avalanche safety protocol at an industrial worksite.

The purpose of the conceptual framework is to support the design and evaluation of avalanche risk reduction services in an organized and contextualized way. It offers guidance to ensure that nothing is overlooked, all elements match the context, and effectiveness can be tracked with relevant criteria. Together, these characteristics make the conceptual framework an ideal approach for examining avalanche commissions

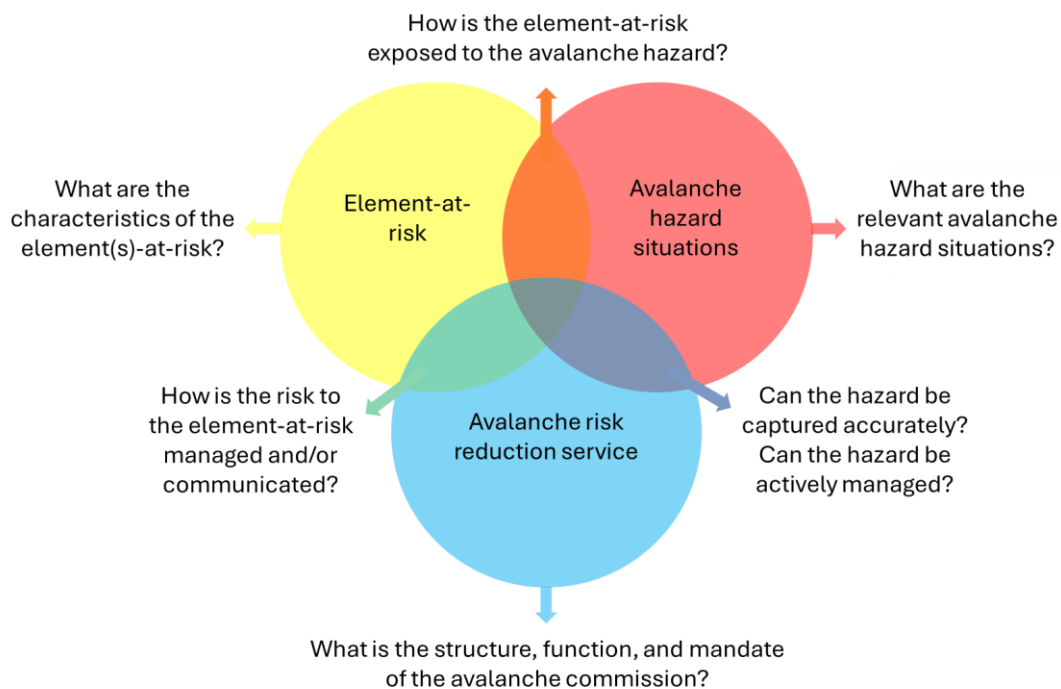


Fig. 1: Conceptual framework for evaluating avalanche risk reduction effectiveness (St. Clair & Haegeli, 2023)

and supporting the existing efforts of the CAIROS and SILS projects (Winkler et al., 2024; Schweizerische Interessengemeinschaft Law-  
insicherheit, 2023).

### 3. EXPECTED OUTCOMES

To support the objectives of the CAIROS project, we will apply the conceptual framework to avalanche commissions. Once we have collected detailed information about the avalanche commissions in our study area, we plan to use audience segmentation methods to identify typical types of avalanche commissions and provide rich descriptions of them.

Audience segmentation is a technique that is commonly used to divide large diverse audiences into smaller and more homogenous groups based on sets of shared characteristics (Slater, 1996; Metag & Schäfer, 2018). Avalanche researchers

have recently begun employing audience segmentation methods that meet this objective in studies of public backcountry recreationists (e.g., Neweduk, 2023; Neweduk & Haegeli, 2023). In addition to typical demographic information, these studies examined individuals' motivations and trip preferences to classify the recreating public into more informative target audiences. The goal is to offer service providers with information on the specific traits and needs of each segment so that they can tailor products and programs to a target audience.

Characterizing avalanche commissions like this across the entire study area will provide a uniquely informative overview of the practitioner community in central Europe. Additionally, the resulting characterizations from the analysis will contain detailed insight into the nature of their element(s)-at-risk, the hazard situations they typically deal with, and how the commissions monitor the conditions, assess the hazard, and make and

Table 2: Preliminary list of defining attributes for principal components and interactions for an avalanche commission characterization

<i>Principal component or interaction</i>	<i>Defining attributes</i>
Component	
Element(s)-at-risk	Single or multiple Type of element at risk (i.e., building, road, forest, people) Static or mobile
Avalanche hazard situation(s)	Avalanche problem type Typical frequency Typical runout length
Risk reduction service(s)	Commission size, organizational structure, and authority Roles and responsibilities Proportion of job focused on avalanche risk management Jurisdiction and legal mandate Commissioner characteristics
Interaction	
Element(s)-at-risk + Hazard situation(s)	Exposure frequency and time Terrain severity (e.g., single path, multiple overlapping paths) Terrain scale (e.g., slope, path, drainage, mountain) Protection infrastructure
Risk reduction service(s) + Hazard situation(s)	Information sources Local observation types Assessment procedures Documentation processes Regulatory environment Mitigation options
Risk reduction service (s) + Element(s)-at-risk	Division of responsibilities Interaction/communication with decision-maker/risk owner Implementation of mitigation measures

implement decisions about how to protect the element(s)-at-risk. Table 2 provides a preliminary list of potential attributes for characterizing the different components of the system in the context of avalanche commissions.

### 3.1. *Example situations*

To offer an idea of how the systems-based framework might organize the complexity in avalanche commissions, we outline the following three illustrative example situations:

1. *Situation 1:* A commission tasked with monitoring conditions for a 1/30yr avalanche event that threatens a small, residential community. The commission has a duty to inform the local mayor of conditions for possible evacuation.
2. *Situation 2:* A commission tasked with daily avalanche hazard assessment of a segment of critical mountain highway exposed to multiple overlapping paths. The commission has a duty to advise transportation authorities of conditions requiring possible road closure.
3. *Situation 3:* A commission tasked with daily avalanche hazard assessment of conditions affecting ski area operations. The commission has a duty to secure terrain utilizing explosive control and terrain closures.

The benefit of these detailed characterizations of common commission contexts is that they offer rich and informative profiles derived from fundamental and distinguishing aspects of risk. As a result, product developers can design information systems or education materials that more accurately capture the nature of the avalanche hazard or more effectively target a particular commissioner profile.

## 4. STUDY PLAN AND INVITATION

In this paper, we introduce a project that aims to conduct a comprehensive survey of avalanche commissioners in mountain regions of Switzerland, Austria, and Italy to identify and segment avalanche commissions into distinct and representative types. The results offer service providers and product developers a context-specific and risk-based foundation that can inform product design and evaluation. Additionally, the results from this study can help set the stage for more robust data collection practices with the potential to offer insight into industry trends affecting succession planning, the use of modern technology, and climate change uncertainties.

We plan to move forward with this project according to the following timeline:

1. Design survey: October-December 2024
2. Distribute survey: January-March 2025
3. Analyze results: April-June 2025
4. Share findings: June-August 2025

We welcome anyone to join the conversation or partner with the survey. Doing this in a similar way, across countries, will allow us to see similarities and differences more easily and benefit from each other's development efforts and product ideas. Please consider participating in the following events during the 2024 ISSW conference: 1) an active workshop Monday evening led by Pascal Haegeli and Walter Steinkogler, and 2) a poster presentation during Friday's session.

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